ME 47500
AUTOMATIC CONTROL SYSTEMS

Course Outcomes  [Related ME Program Outcomes in brackets]
1. Provide a thorough understanding of characterization of dynamic systems for analyzing, predicting, and specifying the performance of an engineered system.  [A1, A2, A3]
2. Provide a thorough treatment of designing classical feedback controllers in time-domain using Root-Locus method.  [A1, A2, A3]
3. Provide a thorough treatment of designing classical feedback controllers in frequency-domain.  [A1, A2, A3, A5]
5. Provide analog and digital feedback controller design experiences through laboratory experiments.  [A1, A2, A3, A4]
6. Sharpen technical communication skills through laboratory and project reports.  [B1]

System Characterization (3 wks)
1. Review and Expand
   • Transfer Functions & Characteristic Equations
   • Transient Response (Higher-order systems)
   • Block Diagram Reduction
2. Stability and Routh-Hurwitz Stability Criterion
3. Steady-State Errors
4. Sensitivity

Root Locus Based Controller Design (3 wks)
1. Root Locus
2. Compensation via Root Locus
   • Lead/Lag
   • PID

Digital Control (4 wks)
1. Introduction to digital systems
2. Effect of sampling
3. Ideal sampler and zero order hold
4. Z-transforms
5. Digital realization of continuous system controller

Frequency Method Based Controller Design (5 wks)
1. Nyquist Stability Criterion
2. Nyquist Diagram Sketching
3. Nyquist Diagram-Gain Margin and Phase Margin
4. Nyquist Diagram to Bode Plots
5. Closed Loop Transient/Closed Loop Frequency/Open Loop Frequency Response Relationships
6. Time Delays
7. Design via Frequency Methods

Laboratory Experiments
1. Introduction to FPGA Hardware, Control Design and Simulation
2. Pulse Width Modulation and Encoders
3. Time Domain Response of Higher Order Systems
4. System Identification
5. Root Locus Analysis
6. PID Control
7. Root Locus Compensator Design
8. Frequency Domain Compensator Design
9. Sampling Time and Digital Control
10. Special Project - Student designed controller to meet a set of given conditions for an unknown system.
1. COURSE NUMBER AND NAME: ME 47500 Automatic Control Systems

2. CREDITS AND CONTACT HOURS: 3 credits
   a. Lecture – 2 days per week at 50 minutes for 16 weeks
   b. Laboratory – 1 day per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:
   G. B. King

4. TEXTBOOK:

5. SPECIFIC COURSE INFORMATION:
   a. Catalog Description: Capability developed in previous courses to model systems and sensors is utilized to design feedback controllers to meet specified system performance objectives. While emphasis is on continuous controllers, an introduction to digital control systems analysis is provided. Laboratory experiments utilizing hardware applications with continuous and digital controllers verify and expand on lecture material. Typically offered in fall and spring.
   b. Prerequisites:
      ME 37500 – System Modeling & Analysis
   c. Status: Restricted Elective

6. SPECIFIC GOALS FOR THE COURSE
   a. Course Outcomes:
      [Related ME Program Outcomes in Brackets]
      1. Provide a thorough understanding of characterization of dynamic systems for analyzing, predicting and specifying the performance of an engineered system. [A1, A2, A3]
      2. Provide a thorough treatment of designing classical feedback controllers in time-domain using Root-Locus method. [A1, A2, A3]
      3. Provide a thorough treatment of designing classical feedback controllers in frequency-domain. [A1, A2, A3, A5]
      5. Provide analog and digital feedback controller design experiences through laboratory experiments. [A1, A2, A3, A4]
      6. Sharpen technical communication skills through laboratory and project reports. [B1]
   b. Related ME Program Outcomes:
      [Related ABET Outcomes Listed in Brackets]
      A1. Engr Fundamentals; B3. Prof/Ethical Responsibility;
      A3. Experimental Skills; B5. Life-Long Learning;
      A4. Modern Engr Tools; C1. Leadership;
      A5. Design Skills; C2. Global Engineering Skills;
      A6. Impact of Engr Solns; C3. Innovation;
      B1. Communication Skills; C4. Entrepreneurship
      B2. Teamwork Skills

7. LIST OF TOPICS: See following page

PREPARED BY: G. B. King

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